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US-A-2 913 111

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Description

This invention relates to a separator suitable for operation at low energy comprising a generally cylindrical outer wall and oppositely disposed end walls defining a substantially closed chamber having a mixture inlet directed to promote a primary, circulating, flow about a swirl axis extending between the end walls, a first phase outlet disposed centrally at one end wall, a second phase outlet disposed in the region of the other end wall, and a flow modifying member disposed within the chamber and extending from a position adjacent the said one end wall into the region of the chamber bounded by the outer wall, the flow modifying member having a passage therein and defining with the outer wall an annular channel which communicates through an annular slot with a region disposed between the flow modifying member and the said one end wall, in which region the first phase outlet is provided, whereby, in use of the separator, a portion of a secondary flow passes from the annular channel through the annular slot to the region between the flow modifying member and the said one end wall and thence away from the said one end wall through the passage in the flow modifying member. The invention is particularly, although not exclusively, concerned with the separation of putrescent solid matter from water in sewerage systems.

A sewer normally receives both storm water and domestic waste, the latter containing putrescent matter. Before the sewage can be discharged, for example into the sea, most of the putrescent matter must be removed, and this is conventionally done by screening and by sedimentation. However, the volume of sewage to be handled, particularly under storm conditions, places a heavy load on the conventional separation equipment, and it is desirable to effect at least a preliminary separation before the sewage reaches the conventional separation equipment.

Cyclone separators are known, for example from US—A—1 509 911 and US—A—2 039 115, for separating dust from air. These separators are high energy devices which function by vigorously rotating the incoming mixture in order to cause the heavier component to move to the outside. They have an outlet for the dust which is in the form of an annular slot adjacent the outer circumferential wall.

Separators constructed on principles applicable to cyclone separators are not generally suitable for sewer systems, because there is usually insufficient space available to provide the pressure head necessary to give the energy required for acceptable efficiency.

According to the present invention, the narrowest dimension of the annular slot extends between the flow modifying member and the said one end wall and is disposed radially inwardly of the outer wall whereby the base of the annular channel is constituted by the portion of the said one end wall disposed radially outwardly of the annular slot, the width of the annular slot being significantly smaller than the radial distance between the flow modifying member and the outer wall.

In an embodiment of the present invention, the flow modifying member has a conical outer surface, with a vertex angle of 60°.

When the separator is used to separate putrescent solids from the sewage, the first phase outlet will be disposed at the bottom of the vortex chamber and will be the outlet for the putrescent solids, while the second phase outlet will be disposed at the top and will be the outlet for the clean water. There may be a trap for collecting floatable solids which would not be discharged through the first phase outlet.

There may be an annular dip plate extending into the vortex chamber, preferably from the top, in order to establish or stabilize a shear zone between a relatively fast outer circulating flow and a slower inner flow.

For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows a section through a phase separator;

Figure 2 illustrates an alternative construction for part of the separator of Figure 1;

Figure 3 is a cross-section taken along the line III—III in Figure 1; and

Figure 4 is a top view of the separator of Figure 1, with some parts removed for clarity.

The separator illustrated in the Figures comprises a cylindrical vortex chamber 2, having an inlet 4 and two outlets 6 and 8. The inlet 4 (see particularly Figure 4), is directed somewhat tangentially so as to promote a circulating flow or swirl in the vortex chamber 2. This effect is enhanced by a deflector plate 10. The flow will circulate about a swirl axis which can be considered to coincide with the central axis of the vortex chamber although fluctuating conditions will mean that this will not always be the case.

The outlet 6 constitutes a solids outlet. As shown in Figure 1, the bottom of the chamber 2 opens into a sump 12, which in turn discharges into the outlet 6. There may be a shut-off valve in the outlet 6. Separated solids will be deposited in the sump 12 in the form of a sludge, and may be discharged intermittently, for example into a mobile tanker. In cases where continuous solids discharge is possible, the sump 12 may be dispensed with, as shown in Figure 2.

Above the outlet 6 there is a flow modifying member in the form of a cone 14. The cone 14 is supported on the base of the vortex chamber 2 by support plates 16, the orientation of which is selected so as to direct the circulating flow inwardly towards the sump 12. There is an upwardly extending passage 18 through the cone 14. The vertex angle of the cone 14 is 60° in the embodiment illustrated, and its dimensions are such that the base of the cone terminates at a

position approximately half way between the central axis of the vortex chamber 2 and the outer wall. The cone thus defines, with the end wall 38 of the chamber 2, an annular slot having a width which is substantially smaller than the radial distance between the cone 14 and the outer wall of the chamber.

As shown in Figure 1, an annular channel is defined between the outer wall, the cone 14 and a portion of the end wall 38. This annular channel communicates, through the annular slot referred to above, with the region between the cone 14 and the end wall 38.

Although the Figures show one particular embodiment of flow modifying member 14, it must be appreciated that the shape and dimensions of the member 14, as well as those of other components of the separator, must be determined largely empirically for operation under given conditions, since it is very difficult to predict by theoretical means how the complex circulating flow of fluid in the separator will behave in practice.

At the top of the vortex chamber 2, there is a baffle plate 20 supported by plates 22 which act as flow spoilers for the clean water flowing to the outlet 8. On its way to the outlet, the clean water passes through an annular slot 21 defined between the baffle plate 20 and the top of the vortex chamber. This reduces the possibility of solid material entering the clean water outlet 8, since such solid material will tend to accumulate near the swirl axis. The outlet 8 extends from an annular chamber 24, which may or may not be closed at the top. An aperture 26 extends through the chamber 24 and the baffle plate 20 to provide access for a cleaning rod which can be passed through the passage 18 and the sump 12 to dislodge solid matter which may adhere to these parts.

At the top of the vortex chamber near the outer wall there is a floatables trap 28 and a floatables outlet 30. The floatables trap 28 comprises a bottom wall 32 and an end wall 34, the construction being such that any solid matter floating on the surface of the water in the vortex chamber is carried round into the trap 28, from which it may be discharged through the outlet 30. In the present embodiment, as is clear from Figure 4, the floatables trap is disposed opposite the outlet 8, and the purpose of this is to reduce the possibility of floatable solids being discharged through the clean water outlet 8. However, apart from this factor, the trap 28 could be disposed anywhere around the circumference of the vortex chamber 2.

An annular dip plate 36 projects downwardly into the chamber 2 from the top wall. As with the dimensions of the cone 14, the position and axial extent of the dip plate 36 must be determined empirically. Its function is to create, or stabilize, a shear zone between an outer, fast-flowing flow and an inner, slower-flowing flow of the mixture in the vortex chamber.

In operation as part of a sewage system, sewage is passed into the vortex chamber 2 through the inlet 4. This creates a circulating flow in the chamber 2 which separates, with the assistance of the dip plate 36, into the outer and inner flows mentioned above. The flow is such that non-floatable solid matter progresses down the lower wall 38 of the vortex chamber 2 and between the plates 16. Some solid matter will, however, be deposited on the outer surface of the cone 14, and the flow will tend to move these deposits slowly up the cone 14. The cone 14 has the effect of creating a secondary flow which circulates upwardly through the passage 18, and then downwardly again over the surface of the cone 14 and between the plates 16. Deposits climbing up the outer wall of the cone 14 will eventually be entrained in this flow and so repeatedly pass between the plates 16 until eventually they are deposited in the sump 12. At the upper end of the chamber, clean water passes through the slot 21 and between the plates 22 into the annular chamber 24 and out of the outlet 8. Under some conditions, this water will be clean enough to pass directly to a tidal outfall. Any floatable solids which will not be passed to the outlet 6 will be caught in the trap 28 and can then either be mixed with the solids issuing from the outlet 6 or else disposed of separately.

The construction of the separator, and in particular the substantially closed top, the annular outlet slot 21, and the cone 14, result in an efficient separation of the solids from the water with a relatively low energy consumption (i.e. requiring only a low pressure head at the inlet 4). Although the invention has been described with primary reference to sewage, the principles can be applied to separation of other mixtures, for example solid/liquid, solid/gas, liquid/gas or liquid/liquid (such as oil and water) mixtures. However, in each case, the shape and dimensions of the various components must be determined empirically to suit the prevailing conditions. By way of example, where oil and water are to be separated and assuming the proportion of oil to water to be small, the separator would operate best with the first phase outlet 6 and the flow modifying member 14 at the top.

Under some circumstances, separation can be made more complete by injecting gas such as air into the inlet 4, causing frothing of the mixture with entrainment of solid particles in the froth.

Claims

1. A separator suitable for operation at low energy comprising a generally cylindrical outer wall and oppositely disposed end walls defining a substantially closed chamber (2) having a mixture inlet (4) directed to promote a primary, circulating, flow about a swirl axis extending between the end walls, a first phase outlet (6) disposed centrally at one end wall (38), a second phase outlet (8) disposed in the region of the other end wall, and a flow modifying member (14) disposed within the chamber (2) and extending from a

position adjacent the said one end wall (38) into the region of the chamber (2) bounded by the outer wall, the flow modifying member (14) having a passage (18) therein and defining with the outer wall an annular channel which communicates through an annular slot with a region disposed between the flow modifying member (14) and the said one end wall (38), in which region the first phase outlet (6) is provided, whereby, in use of the separator, a portion of a secondary flow passes from the annular channel through the annular slot to the region between the flow modifying member (14) and the said one end wall (38) and thence away from the said one end wall (38) through the passage (18) in the flow modifying member (14), characterized in that the narrowest dimension of the annular slot extends between the flow modifying member (14) and the said one end wall (38) and is disposed radially inwardly of the outer wall whereby the base of the annular channel is constituted by the portion of the said one end wall disposed radially outwardly of the annular slot, the width of the annular slot being significantly smaller than the radial distance between the flow modifying member (14) and the outer wall.

2. A separator as claimed in claim 1, characterized in that the flow modifying member (14) has a conical outer surface.

3. A separator as claimed in claim 2, characterized in that the vertex angle of the conical outer surface is 60°.

4. A separator as claimed in claim 2 or 3, characterized in that the base of the cone terminates at a position approximately midway between the central axis of the chamber and the outer wall.

5. A separator as claimed in any one of the preceding claims, characterized in that the flow modifying member (14) is supported on the said one end wall (38) of the chamber (2) by support plates (16) which are oriented to direct flow from the chamber (2) to the first phase outlet (6).

6. A separator as claimed in any one of the preceding claims, characterized in that flow from the chamber (2) enters the second phase outlet (8) through a further annular slot (21) which is centered on the swirl axis and is defined between a baffle plate (20) and the said other end wall.

7. A separator as claimed in any one of the preceding claims, characterized in that a trap (28) is provided for collecting floatable solids.

8. A separator as claimed in any one of the preceding claims, characterized in that an annular dip plate (36) extends into the chamber (2) from one end wall in order to establish or stabilize, in use, a shear zone between a relatively fast outer circulating flow and a slower inner flow.

9. A separator as claimed in any one of the preceding claims, characterized in that the swirl axis extends upwardly.

10. A separator as claimed in claim 9, characterized in that the first phase outlet (6) is at the bottom of the chamber (2) and in which the second phase outlet (8) is at the top.

11. A separator as claimed in any one of the preceding claims, characterized in that gas injection means is provided for injecting air into the mixture inlet (4).

Patentansprüche

1. Ein für den Betrieb mit niedriger Energie geeigneter Separator mit einer im wesentlichen zylindrischen Außenwand und mit einander gegenüberliegend angeordneten Stirnwänden, welche eine im wesentlichen geschlossene Kammer (2) definieren, die einen Mischungseinlaß (4) besitzt, der so gerichtet ist, daß um eine sich zwischen den Stirnwänden erstreckende Wirbelachse eine Hauptumwälzströmung bewirkt wird, und die einen zentrisch zu einer Stirnwand (38) angeordneten ersten Phasenauslaß (6) und einen im Bereiche der anderen Stirnwand angeordneten zweiten Phasenauslaß (8) und ein innerhalb der Kammer (2) angeordnetes und sich von einer der erwähnten einen Stirnwand (38) benachbarten Stelle in den von der Außenwand begrenzten Bereich der Kammer erstreckendes Strömungsleitglied (14) besitzt, wobei das Strömungsleitglied einen darin vorgesehenen Durchlaß (18) besitzt und mit der Außenwand einen über einen Ringschlitz mit dem zwischen dem Strömungsleitglied (14) und der erwähnten einen Stirnwand befindlichen Bereich in Verbindung stehenden Ringkanal bildet und in dem erwähnten Bereich der erste Phasenauslaß (6) vorgesehen ist, womit bei Verwendung des Separators ein Teil einer Sekundärströmung aus dem Ringkanal über den Ringschlitz in den Bereich zwischen dem Strömungsleitglied (14) und der erwähnten einen Stirnwand (38) und dann von dieser einen Stirnwand (38) weg durch den Durchlaß (18) im Strömungsleitglied (14) strömt, dadurch gekennzeichnet, daß die engste Abmessung des Ringschlitzes sich zwischen dem Strömungsleitglied (14) und der erwähnten einen Stirnwand (38) erstreckt, wobei diese engste Abmessung radial einwärts der Außenwand vorgesehen ist, womit die Basis des Ringkanals von den radial auswärts des Ringschlitzes gelegenen Teil der erwähnten einen Stirnwand gebildet ist, und wobei die Breite des Ringschlitzes wesentlich kleiner ist als der radiale Abstand zwischen dem Strömungsleitglied (14) und der Außenwand.

2. Separator nach Anspruch 1, dadurch gekennzeichnet, daß das Strömungsleitglied (14) eine konische Außenfläche besitzt.

3. Separator nach Anspruch 2, dadurch gekennzeichnet, daß der Scheitelwinkel der konischen Außenfläche 60° beträgt.

4. Separator nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die Basis des Kegels an einer etwa in der Mitte zwischen der zentralen Achse der Kammer und der Außenwand gelegenen Stelle endet.

5. Separator nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das Strömungsleitglied (14) an der erwähnten einen Stirnwand (38) der Kammer (2) durch Stützplatten (16) abgestützt ist, welche so orientiert

sind, daß sie die Strömung aus der Kammer (2) zum ersten Phasenauslaß (6) richten.

6. Separator nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Strömung aus der Kammer (2) in den zweiten Phasenauslaß (8) über einen weiteren Ringschlitz (21) eintritt, welcher zur Wirbelachse zentriert und zwischen einer Prallplatte (20) und der erwähnten anderen Stirnwand ausgebildet ist.

7. Separator nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß eine Falle (28) für das Auffangen flotierbarer Feststoffe vorgesehen ist.

8. Separator nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß sich von einer Stirnwand eine ringförmige Tauchplatte (36) in die Kammer (2) erstreckt, um im Betrieb zwischen einer relativ schnellen äußeren Umwälzströmung und einer langsameren inneren Strömung eine Scherzone auszubilden oder zu stabilisieren.

9. Separator nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß sich die Wirbelachse nach oben erstreckt.

10. Separator nach Anspruch 9, dadurch gekennzeichnet, daß der erste Phasenauslaß (6) am Boden der Kammer (2) vorgesehen ist und der zweite Phasenauslaß (8) sich an der Oberseite befindet.

11. Separator nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß eine Gaseinblaseinrichtung zum Einblasen von Luft in den Mischungseinlaß (4) vorgesehen ist.

Revendications

1. Un séparateur approprié pour fonctionner à faible énergie, comprenant: une paroi extérieure généralement cylindrique et des parois d'extrémité disposées en regard définissant une chambre rigoureusement close (2) comportant une admission de mélange (4) orientée de façon à promouvoir un débit circulatoire primaire autour d'un axe de tourbillonnement s'étendant entre les parois d'extrémité; un échappement de première phase (6) disposé centralement à une paroi d'extrémité (38); en échappement de deuxième phase (8) disposé dans la zône de l'autre paroi d'extrémité; et un élément modificateur de débit (14) disposé à l'intérieur de la chambre (2) et s'étendant à partir d'une position adjacente à ladite paroi d'extrémité (38) dans la zône de la chambre (2) délimitée par la paroi extérieure, l'élément modificateur de débit (14) comportant intérieurement un passage (18) et définissant avec la paroi extérieure un canal annulaire qui communique par l'intermédiaire d'une fente annulaire avec une zône disposée entre l'élément modificateur de débit (14) et ladite paroi d'extrémité (38), zône dans laquelle est prévu l'échappement de première phase, une partie du débit secondaire, lors du fonctionnement du séparateur, passant ainsi, par l'intermédiaire de la fente annulaire, vers la zône entre l'élément modificateur de débit (14) et ladite paroi d'extrémité (38), et partant ainsi de ladite paroi d'extrémité (38) par l'intermédiaire du passage (18) dans l'élément modificateur de débit (14), ledit séparateur étant caractérisé en ce que la dimension la plus étroite de la fente annulaire s'étend entre l'élément modificateur de débit (14) et ladite paroi d'extrémité (38) et est disposée radialement intérieurement par rapport à la paroi extérieure, la base du canal annulaire étant constituée par la partie de ladite paroi d'extrémité disposée radialement extérieurement par rapport à la fente annulaire, la largeur de la fente annulaire étant sensiblement plus petite que la distance radiale entre l'élément modificateur de débit (14) et la paroi extérieure.

2. Un séparateur selon la revendication 1, caractérisé en ce que l'élément modificateur de débit (14) présente une surface extérieure conique.

3. Un séparateur selon la revendication 2, caractérisé en ce que l'angle sommital conique de la surface extérieure conique est de 60°.

4. Un séparateur selon la revendication 2 ou 3, caractérisé en ce que la base du cône se termine sur une position approximativement à mi-distance entre l'axe central de la chambre et la paroi extérieure.

5. Un séparateur selon l'une quelconque des revendications précédentes, caractérisé en ce que l'élément modificateur de débit (14) est supporté sur ladite paroi d'extrémité (38) de la chambre (2) par des plaques supports (16) qui sont orientées de façon à diriger le débit à partir de la chambre (2) en direction de l'échappement de première phase (6).

6. Un séparateur selon l'une quelconque des revendications précédentes, caractérisé en ce que le débit provenant de la chambre (2) pénètre dans l'échappement de deuxième phase (8) par l'intermédiaire d'une autre fente annulaire (21) qui est centrée sur l'axe de tourbillonnement et qui est définie entre une plaque chicane (20) et ladite autre paroi d'extrémité.

7. Un séparateur selon l'une quelconque des revendications précédentes, caractérisé en ce qu'un piège (28) est prévu pour receuillir les matières flottantes solides.

8. Un séparateur selon l'une quelconque des revendications précédentes, caractérisé en ce qu'une plaque plongeante (36) s'étend dans la chambre (2) à partir d'une paroi d'extrémité de façon à établir ou stabiliser, lors du fonctionnement, une zône de cisaillement entre un débit circulatoire extérieur relativement rapide et un débit intérieur plus lente.

9. Un séparateur selon l'une quelconque des revendications précédentes, caractérisé en ce que l'axe de tourbillonnement s'étend en direction du haut.

10. Un séparateur selon la revendication 9, caractérisé en ce que l'échappement de première phase (6) se trouve au bas de la chambre (2), l'échappement de deuxième phase (8) se trouvant dans le haut.

11. Un séparateur selon l'une quelconque des revendications précédentes, caractérisé en ce qu'un moyen d'injection de gaz est prévu pour injecter de l'air dans l'admission de mélange (4).

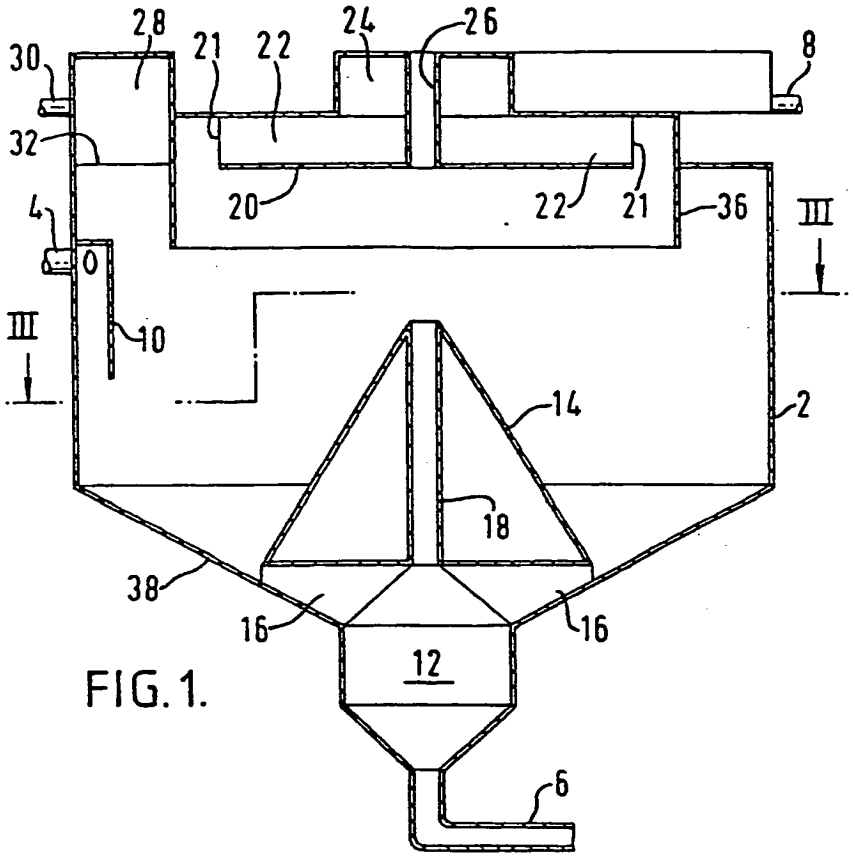

FIG. 1.

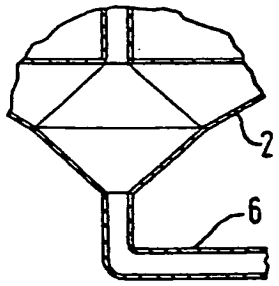

FIG. 2.

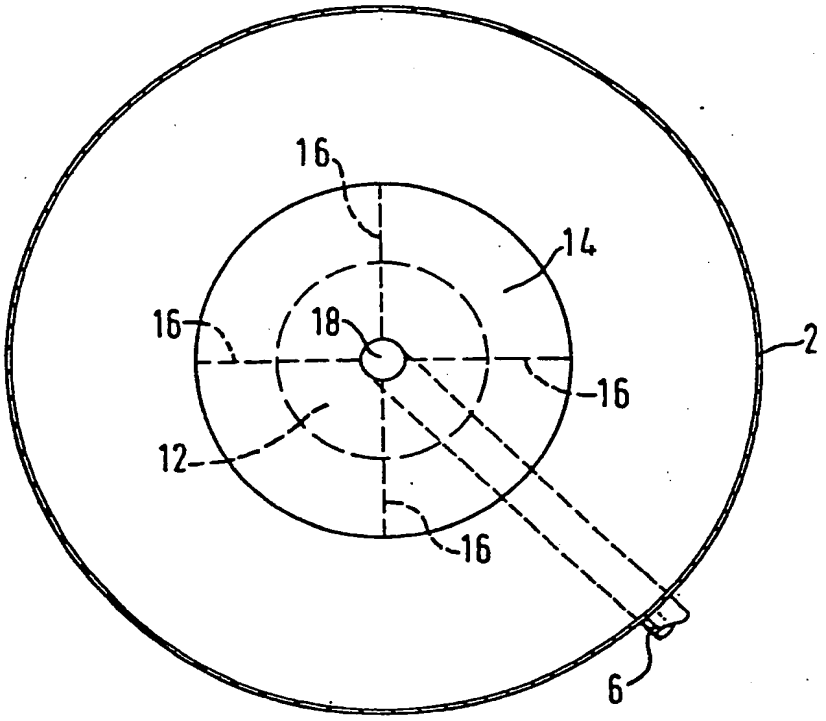

FIG. 3.

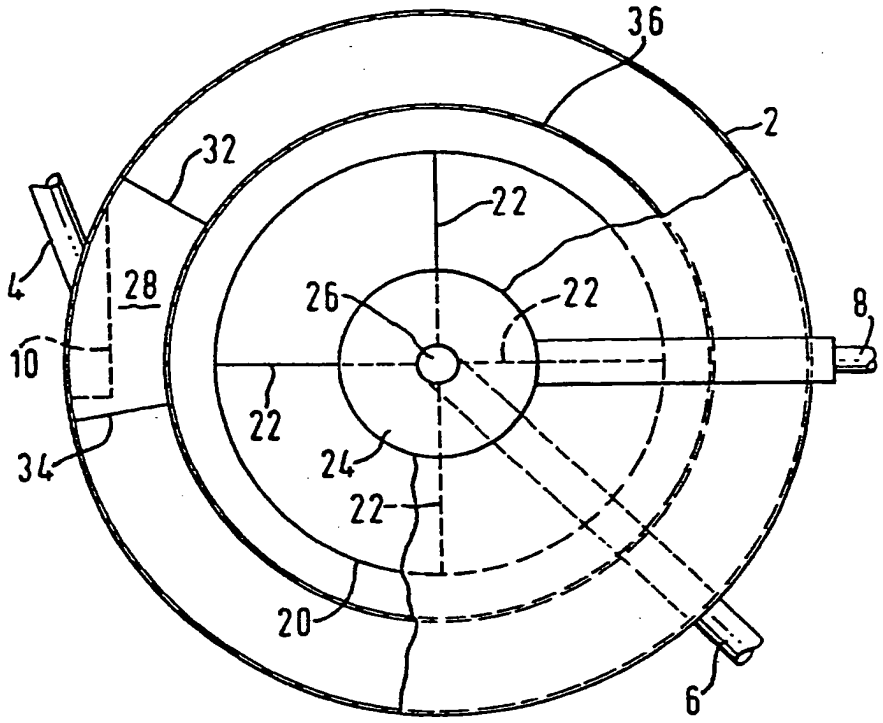

FIG. 4.